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Extraction of Zr and Hf using TBP and TIOA for the chemistry of element 104 Rf

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Chemical properties of transactinide elements ($Z \geq 104$), superheavy elements, are unexpected from the properties of its homologues in the periodic table due to strong relativistic effect on the orbital electrons in the heavy elements. Studies on the transactinide elements have, therefore, attracted many scientists. On the other hand, it is very difficult to perform chemical experiments of these elements because of their short half-lives and low production rates. Rapid chemical experiments on “one-atom-at-a-time” basis are needed. Although there are some pioneering researches conducting chemical separations, studies obtaining chemical constants in equilibrium are a few especially in solution chemistry.

In the present study, the distribution ratios in solvent extraction and distribution coefficients in solid-liquid extraction were determined for Zr and Hf as the homologues of rutherfordium (Rf, $Z=104$) in the triisooctylamine (TIOA)/HCl and tributylphosphate (TBP)/HCl systems by batch method. From these results, we discussed the chloride complexation and chemical species extracted, and determined the experimental conditions for the extraction of Rf. Based on the comparison of these data with those obtained for Rf, we would clarify the properties in the chloride complex formation of Rf.

Two types of rapid extraction apparatuses are under development to obtain the extraction data of Rf in equilibrium. For solvent extraction, a micro-chemical tip, Teflon capillary tube, and micro mixer device were tested as a mixing section of the solvent extraction apparatus using Zr and Hf radiotracers. As a result, it is found that rapid chemical reactions were observed in using the micro-chemical tip. Solid-liquid extraction apparatus which can perform rapidly solid-liquid extraction by batch method was also developed. By this apparatus, time dependence of the distribution coefficients are expected to be obtained for superheavy elements. Performance of this apparatus was checked by the on-line experiment using the accelerator.

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